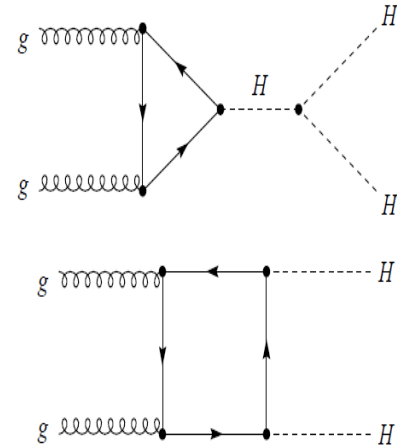


# Studies of $HH \rightarrow b\bar{b}\gamma\gamma$ for Higgs self-coupling measurements at the future hadron colliders

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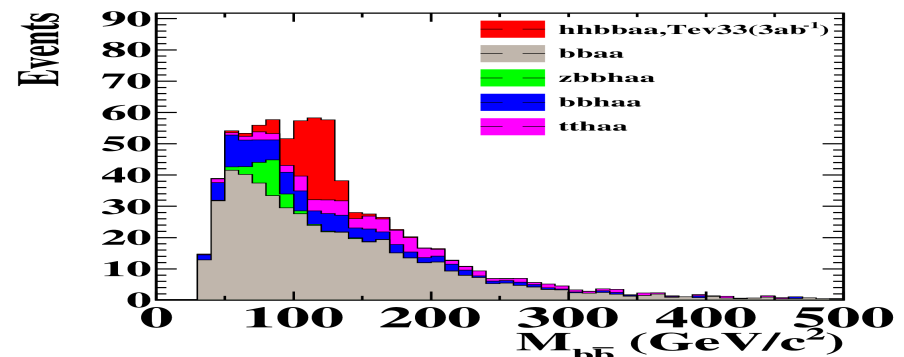
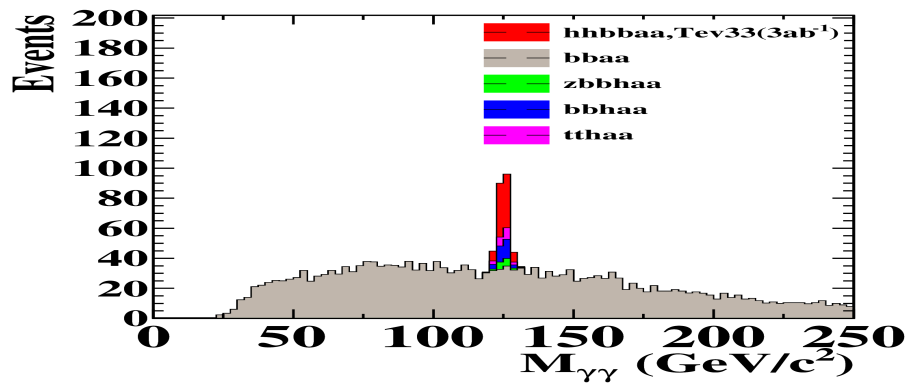


- Observing HH seems challenging at HL-LHC:
  - Destructive interference between HHH and  $gg \rightarrow HH$
  - Possible  $3\sigma$  evidence from each experiment with  $3ab^{-1}$  data.
- Investigating how feasible to observe  $HH \rightarrow b\bar{b}\gamma\gamma$  at VLHC where the  $\sigma_{HH}$  increases from 34 fb at  $\sqrt{s}=14\text{TeV}$  to 1428 fb at  $\sqrt{s}=100\text{TeV}$ .
- Simulation setup: Delphes V3,0.10 with ATLAS responses
  - Signal: Hpair+Pythia6.2
  - Backgrounds: MadGraph5.11, CKKW match up to 2 partons
- Event selections:
  - $2\gamma, 2b$ 's ( $P_t > 35$ ),  $\Delta R_{\gamma\gamma} (\Delta R_{bb}) < 2.5$ ,  $|\cos\theta_H| < 0.8$ ,  $\Delta M_{\gamma\gamma} < 5$ ,  $\Delta M_{bb} < 25\text{GeV}$
  - Extra jets+ leptons+met < 2,  $P_{t_H} > 100\text{ GeV}$ ,  $M_{HH} > 300\text{ GeV}$ .

# Results and Conclusion

- Expected  $S/\sqrt{B} \sim 2.3, 6.2, 15$  for  $\sqrt{s}=14, 33, 100$  TeV with  $3 \text{ ab}^{-1}$ .

Samples	HL-LHC ( $3 \text{ ab}^{-1}$ )			TeV33 ( $3 \text{ ab}^{-1}$ )			TeV100 ( $3 \text{ ab}^{-1}$ )		
	$\sigma \cdot Br$ (fb)	Acc. (%)	Expect Evnts	$\sigma \cdot Br$ (fb)	Acc. (%)	Expect Evnts	$\sigma \cdot Br$ (fb)	Acc. (%)	Expect Evnts
HH( $bb\gamma\gamma$ )	0.089	6.2	16.6	0.545	5.04	82.4	3.73	3.61	403.9
$bb\gamma\gamma$	294	0.0045	40.1	1085	0.0039	126.4	5037	0.00275	415.4
$z(b\bar{b})h(\gamma\gamma)$	0.109	1.48	4.86	0.278	1.41	11.8	0.875	1.57	41.2
$b\bar{b}h(\gamma\gamma)$	2.23	0.072	4.82	9.84	0.084	24.8	50.5	0.099	150.5
$t\bar{t}h(\gamma\gamma)$	0.676	0.178	3.62	4.76	0.12	16.5	37.3	0.11	124.2
Total B	-	-	53.4	-	-	179.5	-	-	731.3
$S/\sqrt{B}$	-	-	2.3	-	-	6.2	-	-	15.0



- Results are consistent with European Strategy studies at HL-LHC.
- The  $bb\gamma\gamma$  QCD production seems dominant source of background.
- With  $3 \text{ ab}^{-1}$ , the Higgs self-coupling could be measured to be  $^{+35\%}_{-23\%}$  ( $^{+15\%}_{-10\%}$ ) statistic only by observing  $HH \rightarrow bb\gamma\gamma$  at  $\sqrt{s}=33$  (100) TeV collider.